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SCIENCE

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THE ECONOMIC TREND OF BOTANY¹

It can scarcely be successfully denied that the most significant recent advances in American botany have been along economic lines. By many of our younger botanists the dominance of the practical point of view is taken for granted, but to some of our older investigators and teachers the changing attitude has brought something of a shock. And there are a few who are not yet conscious of the great economic tide which is engulfing us. For the sake of this last group it will be well to consider briefly a few historical facts. As yet within the memory of the older living botanists, American botany was scarcely more than the taxonomy of the vascular plants. In the eighties we began importing the laboratory method from Europe, particularly from Germany. It was the psychological moment, and naturalization took place with surprising swiftness. At first, the new movement found expression mainly in the direction of morphology and anatomy. By the early nineties, however, a pronounced physiological trend found large place, and in the late nineties ecologists began taking the laboratory method to the field.

No attempt will be made to picture here the rise of economic botany. It may be pointed out, merely, that in our older programs it had very little place. A somewhat notable exception to this is afforded by medical botany, which has long been paid attention to by botanists. Indeed,

¹ Address of the vice-president and chairman of Section G, Botany, American Association for the Advancement of Science, Philadelphia, December, 1914.

botany almost began with an attempt to find the cures for human ills. So it was natural enough that posts of botany in the olden time should be assigned so generally to physicians, and that so many physicians should cultivate botanical science. Even to-day, in many European universities botanists who know nothing of such things are often obliged to give lectures along these lines to medical students.

It is only a few years ago that our botanical programs were made up almost entirely of the reports of investigations in what we are accustomed to call pure science, as though applied science were impure. But see what we have to-day! It is a conservative estimate to say that three fourths of our botanical investigation is now along economic lines, as compared with essentially none at all, when the oldest among us were beginning botanical research.

If one were to count the titles in the present program of the Botanical Society of America, he might be inclined to dispute this statement, but it must be remembered that the majority of the economic papers are now given in the various technical societies. Immediately previous to the formation of the American Phytopathological Society, approximately half of the titles offered in the combined programs of Section G and the Botanical Society were phytopathological. If we take account of the work done by the various divisions of the United States Department of Agriculture and by the many state agricultural colleges and experiment stations, by workers in bacteriology and plant breeding, and by investigators in the forest service, it will be realized that more rather than less than 75 per cent. of our botanical investigation is economic.

Whatever may have been the scientific deficiency of much of this work in the past

and of part of it to-day, it must be admitted that there is coming from these sources an increasing body of work of the highest value scientifically. This is well indicated by the *Journal of Agricultural Research*, which from the first number has taken rank with our best botanical journals.

It is scarcely to be supposed that economic botany is a passing fad, and that pure botany, as we call it, will once again come into a place of dominance. The shifting emphasis in botany is but a part of a great movement as broad as humanity itself. The three sections that have been most recently organized in the American Association for the Advancement of Science are practical rather than theoretical, and the last of these, agriculture, is one which is looming up everywhere as a competitor of botany. Chemistry and physics also are being swept with the same economic title.

No better index is to be seen of the trend of the time than in the curricula of schools and colleges. Once the central feature of our educational system was the disciplinary study of the classics. Latin and Greek, subjects which survived the barbarism of the middle ages and the changing viewpoints of subsequent centuries, have given way before our modern demand for culture that is practical; and it is doubtful if they can ever again take a leading place in educational systems. In many of our secondary schools botany has given way, and perhaps permanently, to agriculture, and in many others agriculture is introduced along with botany, or the demand is made that botany be made practical. Naturally the last institutions to feel the press of the new movement will be the private or endowed institutions, such as the University of Chicago, from which your speaker comes. But even we are feeling it. An increasing number of our stu-

dents are demanding more practical courses or are going elsewhere through failure to find them with us, and what is more, an increasing number of schools are demanding teachers with more practical training than we have been supplying. Last summer one of our graduates, well trained in theoretical botany, was offered a position if she could teach agriculture. Fortunately we had imported a professor of agriculture for the summer, and the young lady took a hurried course, and secured the position. An increasing number of opportunities are offered to qualified graduates prepared to take up work in agricultural colleges and experiment stations, and a relatively decreasing number of places are available in theoretical botany.

If the situation above depicted is a general movement rather than a passing whim, it is evident that in many of our institutions botany to remain a living force must change its methods. It may, as did Latin and Greek, stand inflexibly for past ideals and decline, or it may adjust itself to present-day problems and live with increasing vitality. We must not be deceived by the fact that more of us than ever before are engaged in the pursuit of theoretical botany. It is not a question of absolute, but of relative, numbers, and by that test theoretical botany is losing. For one, I mourn the passing of Greek and Latin. To me those languages have been immensely practical and I do not at all regret the seven years I employed in their study. Yet how much better off we all would be had the classics, as we took them, been related to our modern life! And they might have been so related, for there are many points of contact, but your teachers and mine held rigidly for classics for the classics' sake and for disciplinary values; and it is for this that they have fallen.

At Chicago, we still adhere to the ancient notion that the A.B. degree should stand for training in the classics, and the result, of course, is a great decline in A.B. graduates. Some convocations pass without a single student taking that degree. One day I asked one of our professors of Latin if the slump in Latin and Greek were general and permanent or merely local and temporary, and he replied with sadness: "I feel that it is world-wide and lasting; even Oxford feels it. Almost the only ray of hope for us is that the botanists still require the diagnoses of species to be in Latin."

It would be a world tragedy if theoretical botany should die, or even if it were to be less influential than it is at present. It is vastly more important than are Greek and Latin, and yet their decline is to be contemplated with profound regret. But botany is the foundation of agriculture, and agriculture is the most fundamental employment of the human race.

To be sure, we can farm without being botanists, but we can not farm so well. Through the ages agricultural man has stumbled on many important facts and principles that the botanist has later on explained, thus making more scientific farming possible. Witness the enrichment of land by growing leguminous crops—a fact mentioned by Pliny, and explained by modern botany, and as a result utilized with vastly increased success by the present-day agriculturist. Witness, too, the history of our knowledge of the wheat rust, or the recently discovered hereditary symbiosis of bacteria and seed plants—phenomena seen by agriculturists as in a glass, but very, very darkly until the theoretical botanists explained them.

In spite of these instances and a hundred more, the practical man is coming increasingly to look with scorn upon the

theoretical botanists. What matters it, say we? Alas, it matters much, unless we happen individually to be endowed. For botanical positions, like other things in life, are controlled by the law of supply and demand. In more than one institution that I know the tenure of position of the botanist depends upon his success in attracting students. The student, needing bread and butter, will not be attracted to lines in which he can not earn it, and, as Mr. Dooley says, "There ye are." In several state universities the clash has already come, and in every case of which I am cognizant, the more practical botany of the agricultural department has won as against the more theoretical botany of the academic department. Even in our private institutions we commonly have practical trustees who sooner or later may see the trend of the time and act accordingly.

Notwithstanding the sorry picture just painted, I suspect that all of us believe at heart that the most fundamental aim of botany is the improvement of the human race. All of us desire as our supremest wish, that we may do something in our brief life to make man's lot better than before we came. Therefore, it remains only to make concrete our inmost ideals, in order to save the day for botany, as it was not saved for Greek and Latin.

A good many years ago I published a paper on the vegetation of the sand dunes of Lake Michigan, depicting the principles of plant succession, as there so strikingly illustrated. Shortly after, with an expression on my face betokening, "There now, isn't that something like?" I gave a copy to a man of the world, who said merely "Well, what of it?" Aghast, I said nothing and only now, fifteen years afterwards, is the answer forthcoming. It is as follows:

Two years ago I was surprised to receive

a message from the United States Department of Justice, asking for my services as an ecological expert in some government cases in Arkansas. With many misgivings, and with the feeling that ecology, as I represent it, was now specifically on trial, I took up the work assigned me. To my unalloyed gratification I discovered that matters which perplexed the Department of Justice were simple enough when examined by an ecologist rather than by an attorney. In 1847 the original survey was made by the United States of the bottom lands along the Mississippi River in eastern Arkansas, and the country was opened for settlement. A great deal of the area was surveyed as permanent lake, and is so shown even on the most recent detailed maps. At the present time these so-called lakes are occupied by heavy timber of great value. Furthermore, this "lake" land is very fertile, and much in demand for raising corn and cotton. However, as it is termed lake in the original survey, it can not be homesteaded and farmed. A few years ago certain lumber interests, having used up the high-grade timber on the surveyed lands, looked with envy on the splendid timber growing in these so-called lakes. Consequently they conceived the idea of purchasing riparian rights from the owners of the adjoining surveyed land, and they proceeded to cut the timber. Shortly afterwards the United States government instituted suit against these lumber interests, its contention being that the original survey was fraudulent, that lakes did not exist in 1847, and that riparian rights therefore did not inhere. In the meantime, pending settlement, provisional entries were made by "squatters." While test suits were made on only a few of these so-called lakes, there exist many tracts of similar nature, involving in the aggregate

many thousands of acres and property values up into millions of dollars.

As an ecologist it was my duty to determine from present indications the nature of these so-called lakes in 1847. The work was ridiculously easy, since it was found that these "Lake beds" were covered with upland timber of great age. The attorneys for the lumber interests endeavored somewhat half-heartedly to show the inaccuracy of the method of determining the age of the trees by a count of the annual rings, but in the face of the hundreds of years of age shown by many of the ring counts, this contention had short shrift.

Somewhat greater efforts were put forth in support of their claim that trees can grow in lakes, much being made of the well-known fact that the bald cypress, *Taxodium distichum*, occurs in well-defined bodies of water. It was here that the ecological argument had its greatest force. Having visited the country of the lower Mississippi on two previous occasions and having made four trips to the territory in question during the course of my work for the government, I was in a position to know the main facts in the ecological succession on the Mississippi bottoms.

Employing the happy terminology of W. S. Cooper, there are two types of hydrarch succession in the area in question, that from the river and that from the lakes which generally are back of the levee or in old cut-offs due to a shifted course of the river. On the river front, as the alluvium is built up, there is frequently seen a sandbar vegetation of ephemeral annuals associated with low summer levels of the river. Back of this there appears the first ligneous vegetation, dominated usually by willows, such as *Salix longifolia* and *S. nigra*. Further back there appear more or less definite stages of vegetation, each stage associated with a water table of a

given depth, culminating in the great river-bottom forests of *Quercus texana*, *Q. lyrata*, *Acer rubrum*, *Liquidambar*, *Celtis*, various hickories, *Populus deltoides*, *Ulmus*, *Platanus*, *Fraxinus americana*, and the like. It is probable that this forest type is not the permanent climax of the region, but rather a very long-enduring temporary climax.

In the lakes, whether formed by the elevation of natural or artificial levees or through the shifting of the river channel, the course of vegetational development is somewhat different. At first there is a pond vegetation with *Nelumbo* and other pond aquatics. Following this one finds at times a flag grass prairie or again a willow belt, much like that of the river front. The most striking feature of these lake successions, however, is the stage dominated by the tupelo, bald cypress and water locust, which usually follows the willow or prairie stage. As shown by the great age of the trees (tupelos of 200 years, and cypress of 700 years having been observed), this stage may last for a long time.

It is particularly important to note that many tupelo and cypress trees were seen to have been killed by submergence during periods of high water, thus showing that these trees are properly trees of the land rather than of the water. If they occur in lakes, as they do, this fact would seem to indicate that the lakes are but temporary, or at least that there were only short periods of particularly high water during their early life. After these trees there comes a forest of red maple, sweet gum, pumpkin ash, planer, pecan, etc., and then again after a lapse of many more years there comes the characteristic forest of the so-called lakes, the temporary climax forest above noted, with its gigantic oaks, hackberries and other trees of the dry ground; therefore, when one cuts an over-

cup or Texan oak and finds it to have an age of 300 years, it is clear from these facts of ecological succession that it has been much more than 300 years since there was a lake, where the trees now are.

Through a study of trees that germinated on these lands in and about 1847 I was able to determine that at that time the conditions were essentially as at present, since in the so-called lake beds the same species of trees are developing now as in 1847. I testified that in the lands in suit the evidence of ecological succession shows beyond all question that even a thousand years ago these so-called lakes must have been land, and it is my firm belief that there have been no lakes in these sites for at least two thousand years.

The physiographic evidence corroborated the ecological evidence in striking fashion. It is a well-known fact that deposit is more rapid on the immediate banks of the Mississippi than farther back, much coarse material being deposited near the shore, whereas further back the material is finer and finer and constantly less in amount. It is this fact that accounts for the formation of the natural levees; thus in these so-called lakes which mostly lie some miles back of the river front, the alluvial accumulation is slight. It is mostly to the much slower accumulation of vegetable material that they owe their gradual elevation above the water table. Excavations near the river and in the so-called lakes brought out this difference most strikingly.

Furthermore, the spur roots which are sent out at the ground line are still uncovered by accumulated alluvium, even on the oldest trees. Had lakes existed in 1847 and been subsequently filled by detritus, it is clear that the spur roots of old trees would be deeply buried. In the so-called lake beds there are many logs of trees that fell in the earthquake of 100 years ago,

and even these logs are still unburied, thus showing an absence of appreciable alluvial accumulation for at least a century.

Two questions may have occurred to you that are more of human than of ecological interest. What was the object of a fraudulent survey of such colossal magnitude, and how were the suits decided? As to the motive of the surveyors, it may be noted merely that in 1847 our government surveyors got a certain sum per mile for ordinary surveying, and considerably more for surveying lake shores because of the greater difficulties involved; it was an object to return lakes, even if the meander lines had to be traced while in camp. As to the decision of the suits, the district judge at Little Rock, in the first test suit, made a sweeping decision in favor of the government as against the lumber interests, though an appeal has been taken to the higher courts. It may be interesting to note that the judge based his decision largely on the ecological facts, in the face of testimony given by some of the oldest inhabitants that they had actually seen the lakes in question! However, other equally old and perhaps more respectable inhabitants testified that conditions in 1847 were essentially as they are to-day. It was brought out in court that it is safer to believe a tree than a man! Thus a line of investigation which we had supposed to be theoretical only has turned out to have large practical significance.

No claim is made, of course, that this is the first demonstration of the utility of ecology. A field of research of almost limitless possibilities is indicated by Shantz's splendid paper on the natural vegetation as crop indicators in the Plains. Just as untold sums of money have been wasted in the search for gold where the geological formation is such that the pres-

ence of gold is impossible, so countless amounts of time and money have been squandered in agricultural experiment on land whose natural vegetation, if studied, would have directed other uses. One of the best applications of ecology is afforded by the work of Coville, on the culture of the blueberry, of which we are to learn something more to-day. The utilization of acid lands by the growth of crops that thrive in the presence of certain organic acids is a large conception and will doubtless prove to be one of the great utilitarian discoveries of our day.

I will not trespass on your time by indicating further practical applications of my chosen field, ecology. Others will suggest themselves, as will similar applications in various lines of botany, particularly in physiology. If we are to keep botany alive and abreast of the time, we who are in academic botanical departments must give more attention than formerly to the economic aspects of our subject. We must offer more courses in the practical phases of botany. In our research we must not avoid practical problems, but look for them, and we must emphasize the practical possibilities of our theoretical problems. Our sister science, zoology, which perhaps is in a more serious plight than we, gives evidence at this meeting of an attempt to meet the situation by choosing for its symposium the significant topic, "The Value of Zoology to Humanity." Above all we must treat the economic relations of our subject, not as an annex, a thing apart, a "sop to Cerberus," but as the vital and essential thing, the very kernel of it all. By pursuing such a course we shall keep in close relationship with our practical modern life, and we shall justify ourselves to our fellows. We shall then have ample opportunity to continue our researches along theoretical lines.

And one may never know how soon a purely academic study may come to be a factor of the first importance in the betterment of the human race.

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CONSERVE THE COLLECTOR

It is with considerable apprehension that I have observed an unmistakable decrease in the number of collectors during the past six or eight years. Matters of precision and accuracy in the field of ornithology are, I have no doubt, suffering as a consequence of this forsaking of the "shotgun method." Our faunistic literature to be of the highest scientific character must be based on the surest means of establishing the identification of species. The "skin record" is essential, and the availability of this is dependent upon the existence and activity of the collector.

The type of field observer who depends solely on long-range identification is becoming more and more prevalent. But the opera-glass student, even if experienced, can not be depended upon to take the place of the collector. Accuracy in identification of species and especially subspecies rests for final appeal upon the actual capture and comparison of specimens. Ornithology as a science is threatened, and it should not be allowed to lapse wholly into the status of a recreation or a hobby, to be indulged in only in a superficial way by amateurs or dilettantes.

It is to be doubted whether authoritative and expert systematic and field ornithologists can be developed through any other process than by personal collecting of adequate numbers of specimens in the field. The processes of hunting, and personal preparation of bird skins, bring a knowledge of the characters of birds, both in life and as pertaining to their structure and plumage, which can be secured in no other way.

The present tendency toward extermination of the collector bears obvious close relationship to the increasing number of extreme sentimentalist. The latter, beginning in a